

*sieve to adsorb an oxygen amount of 50% of a saturated oxygen adsorption amount starting from the beginning of oxygen supply is 5-10 seconds and a period "TN" needed for the carbon molecular sieve to adsorb a nitrogen amount of 50% of a saturated nitrogen adsorption amount starting from the beginning of nitrogen supply is larger than "TO" by more than 41 times, the purity of the nitrogen product ranges from 99% to 99.999%, and the regeneration of the adsorbent is conducted under atmospheric pressure. The features are recited in independent claims 1 and 4 as follows, marked with underlines:*

1. A method for producing nitrogen using a pressure swing adsorption (PSA) method with air as a raw material, comprising:

having the air contact with an adsorbent that comprises a carbon molecular sieve selectively adsorbing oxygen to produce nitrogen with a purity ranging from 99% to 99.999% by using the pressure swing adsorption (PSA) method that conducts regeneration of the adsorbent under atmospheric pressure, wherein

a period "TO" needed for the carbon molecular sieve to adsorb an oxygen amount of 50% of a saturated oxygen adsorption amount starting from the beginning of oxygen supply is 5-10 seconds, and a period "TN" needed for the carbon molecular sieve to adsorb a nitrogen amount of 50% of a saturated nitrogen adsorption amount starting from the beginning of nitrogen supply is larger than "TO" by more than 41 times.

4. An apparatus for producing nitrogen with a purity ranging from 99% to 99.999% using air as a raw material, comprising:

.....  
in said at least one adsorbing column, an adsorption step and a depressurization regeneration step are switched alternatively and periodically to implement a pressure swing adsorption (PSA) process, wherein the adsorption step comprises conducting a raw air compressively into the adsorbing column, and the depressurization regeneration step comprises releasing a compressed gas under atmospheric pressure after the adsorption step; and

the adsorbent is a carbon molecular sieve that selectively adsorbs oxygen, which adsorbs an oxygen amount of 50% of a saturated oxygen adsorption amount with a period "TO" of 5-10 seconds starting from the beginning of oxygen supply, and adsorbs a nitrogen amount of 50% of a saturated nitrogen adsorption amount with a period "TN" starting from the beginning of nitrogen supply, wherein TN is larger than TO by more than 41 times.

Auvil et al. stress that a CMS preferably has a high oxygen volumetric capacity for higher recovery and productivity in PSA, as described in col. 5, lines 2-7: "we have discovered

that the exceptionally **high oxygen volumetric capacity** of the CMS enables higher recovery and productivity in PSA than commercial CMS, even if the high capacity CMS has a slower oxygen uptake rate and a lower  $O_{2}/N_{2}$  kinetic selectivity than the commercial CMS”.

Auvil et al. **teach away** to use a CMS having an  $O_{2}/N_{2}$  kinetic selectivity higher than 41 as in this invention, because **the effect of increasing the  $O_{2}/N_{2}$  kinetic selectivity from 36 to 72 is small** as compared with the effect of increasing the oxygen volumetric capacity by only 50% in Auvil et al. As described in Example 60 of Auvil et al.: “The process improvements resulting from increasing selectivity by 100% are **only about 60%** of those obtained by increasing capacity by only 50% (Example 58)” (col. 26, lines 6-9). Therefore, one skilled in the art is not motivated to increase the  $O_{2}/N_{2}$  kinetic selectivity of the CMS from 36 to 72, i.e., to use a CMS having an  $O_{2}/N_{2}$  kinetic selectivity higher than 41, in view of Auvil et al.

Moreover, the CMS mentioned in Examples 57-60 of Auvil et al. is simply a theoretical CMS that does not exist in real world, since it is impossible to have the same  $N_{2}$  uptake rate as the  $O_{2}$  uptake rate is doubled (the  $O_{2}$  uptake time is decreased from 31s in Examples 57-59 to 15.5s in Example 60, while the  $N_{2}$  uptake time is 1127s through Examples 57-60). According to the results of Applicants’ experiments shown in Table 1, **the  $N_{2}$  uptake rate changes almost proportionally to the  $O_{2}$  uptake rate**. Therefore, the CMS in Examples 57-60 does not exist in real world, and Example 60 is not accomplishable and cannot be a prior method of this invention.

Furthermore, Auvil et al. does not disclose that the CMS in Example 60 can be used to produce a nitrogen product having a purity of 99%-99.999%. Meanwhile, **Gemba et al. cannot produce a nitrogen product having a purity of 99%-99.999% with a regeneration of the adsorbent under atmospheric pressure**. Please refer to Table 1 in Gemba et al., as the

regeneration is conducted **under atmospheric pressure**, the minimal residual oxygen concentration in nitrogen is 0.64% (6400 ppm), and **nitrogen of 99.99% (100 ppm of oxygen) in purity is not obtained**. On the other hand, as shown in col. 15, line 35 – col. 16, line 2 of Gemba et al., especially in col. 15, lines 37-38, when **a nitrogen product of 99.99% in purity is to be obtained**, the regeneration must be conducted under vacuum (~80 Torr), but **not under atmospheric pressure**. Therefore, the feature of producing nitrogen of 99%-99.999% in purity with a regeneration step under atmospheric pressure is not taught or suggested in Gemba et al.

Accordingly, at least the features of *“using a CMS having a TO of 5-10 seconds and a TN/TO ratio higher than 41”* and *“producing nitrogen of 99%-99.999% in purity with a regeneration step under atmospheric pressure”* are not taught or suggested in the combination of Auvil et al. and Gemba et al.

For at least the reasons mentioned above, Applicants respectfully submit that independent claims 1 and 4 patentably define over the prior art.

### **Rejections of Claims 2-3**

Claims 2-3 were rejected under 35 U.S.C. 103(a) as being unpatentable over Auvil et al. in view of Gemba et al.

Claims 2-3 have the aforementioned features of claim 1 since they are dependent from claim 1. The aforementioned emphasized features are not suggested or taught by Auvil et al. and Gemba et al., taken alone or in combination, and respectfully request that the rejections of these claims be withdrawn.

For at least the same reasons provided for overcoming the rejections of claims 1 and 4,

Customer No.: 3156/  
Application No. 10 064,753  
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Applicants respectfully submit that claims 2-3 dependent from claim 1 also patently define over the prior art.

**CONCLUSION**

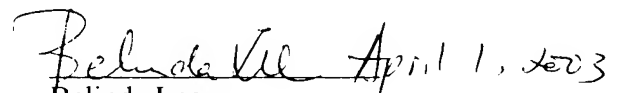
For at least the foregoing reasons, it is believed that pending claims 1-4 are in proper condition for allowance. If the Examiner believes that a telephone conference would expedite the examination of the above-identified patent application, the Examiner is invited to call the undersigned.

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Respectfully submitted

  
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**VERSION WITH MARKINGS TO SHOW WHERE CHANGES MADE**

**In The Claims**

Please amend claims 1 and 4 as follows:

1. A method for producing nitrogen using a pressure swing adsorption (PSA) method with air as a raw material, comprising:

having the air contact with an adsorbent that comprises a carbon molecular sieve selectively adsorbing oxygen to produce nitrogen with a purity ranging from 99% to 99.999% by using the pressure swing adsorption (PSA) method that conducts regeneration of the adsorbent under atmospheric pressure, wherein

a period "TO" needed for the carbon molecular sieve to adsorb an oxygen amount of 50% of a saturated oxygen adsorption amount starting from the beginning of oxygen supply is 5~10 seconds, and a period "TN" needed for the carbon molecular sieve to adsorb a nitrogen amount of 50% of a saturated nitrogen adsorption amount starting from the beginning of nitrogen supply is larger than "TO" by more than 41 times.

4. An apparatus for producing nitrogen with a purity ranging from 99% to 99.999% using air as a raw material, comprising:

an air compressor for compressing the air;

a dryer for removing water from the compressed air;

at least one adsorbing column into which the dried and compressed air is conducted, the adsorbing column being filled with an adsorbent that selectively adsorbs oxygen; and

a product tank for temporarily storing a nitrogen product conducted out of the adsorbing column after oxygen is removed in the adsorbing column, wherein

in said at least one adsorbing column, an adsorption step and a depressurization regeneration step are switched alternatively and periodically to implement a pressure swing adsorption (PSA) process, wherein the adsorption step comprises conducting a raw air compressively into the adsorbing column, and the depressurization regeneration step comprises releasing a compressed gas under atmospheric pressure after the adsorption step; and

the adsorbent is a carbon molecular sieve that selectively adsorbs oxygen, which adsorbs an oxygen amount of 50% of a saturated oxygen adsorption amount with a period "TO" of 5~10 seconds starting from the beginning of oxygen supply, and adsorbs a nitrogen amount of 50% of a saturated nitrogen adsorption amount with a period "TN" starting from the beginning of nitrogen supply, wherein TN is larger than TO by more than 41 times.